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ABSTRACT

A description of the University of Southern California (USC) faculty model and some of the results obtained from using the model are presented. The model traces faculty cohorts from 1974 to 1984, under given policies of hiring, tenure, promotion, and retirement. The model takes into account resignations, deaths, anticipated enrollments, and costs. It produces data on anticipated faculty costs, tenure percentages, average age and age distribution, rank distributions, and openings. Its primary use is as a tool for policy analysis. Five explorations made with the model are explored: benign, conservative, and Draconian policies (reflecting "soft," "hard," and "very hard" environments); sensitivity analysis (showing that tenure policy, ranks of replacements, and resignation rates can have major impacts but that promotion policies for associate professors and early retirement schemes are, by themselves, not significant); equal employment opportunities (demonstrating that the rate at which females have to be hired to reach the level of the "availability pool" in 10 years exceeds the current availability pool levels); effect of changing faculty size (for determining appropriate strategies under conditions of growth and decline); and with schools other than USC. Extensive appendices describe the model in detail, discuss validation, present sample output, and show alternative methods of modeling faculty costs. (Author/PHR)

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THE USC FACULTY MODEL

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THE USC FACULTY MODEL

ABSTRACT

This paper presents a description of the USC Faculty Planning Model and some of the results that have been obtained using the model.

The model traces faculty cohorts year by year into the future under given policies of hiring, tenure, promotion, and retirement. It takes into account resignations, deaths, and faculty salaries, and produces output data on faculty salary costs, tenure percentages, average age, age distribution, rank distribution, and openings. Its primary use is as a tool for policy and analysis and planning since the user can specify a wide range of conditions for the input variables and study their interactive impact on the characteristics of future faculty. A series of appendices describe the model in detail, discuss validation, present sample output, and show alternative methods of modeling faculty costs.

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SUMMARY

This paper presents a description of the USC Faculty Model and some of the results that have been obtained from using the model.

The model traces faculty cohorts year by year into the future, under given policies of hiring, tenure, promotion, and retirement. The model takes into account resignations, deaths, anticipated enrollments, and costs. It produces data on anticipated faculty costs, tenure percentages, average age and age distribution, rank distributions, and openings. Its primary use is as a tool for policy analysis since the user can specify a wide range of conditions for the policy variables.

Five explorations made with the model are reported:

1. Benign, Conservative, and Draconian Policies. These policies reflect "soft", "hard" and "very hard" environments. It is shown possible to maintain stable conditions under steady state without resorting to a "very hard" environment.

2. Sensitivity Analysis. One variable was varied at a time to determine which were critical. It is shown that tenure policy, ranks of replacements, and resignation rates can have major impacts but that promotion policies for associate professors and early retirement schemes are, by themselves, not significant.

3. Equal Employment Opportunities. An analysis of the rate at which females have to be hired to reach the level of the "availability pool" demonstrates that an individual school must hire above the current availability pool to be able to catch up even in 10 years.

4. Effect of Changing Faculty Size. The model can be used to determine appropriate strategies under conditions of growth and decline.

5. Schools other than USC. The model has been run successfully for a number of schools other than USC and can easily be transferred.

A series of appendices describe the model in detail, discuss validation, present sample output, and show alternative methods of modeling faculty costs.

INTRODUCTION

In universities and colleges, next year's faculty will differ only slightly from this year's faculty. It is these slight year-to-year differences, however, which provide the opportunity for

- maintaining faculty vitality
- developing new academic initiatives
- maintaining economic viability

in the face of

- inflation and recession
- declining birthrates
- possibly changing attitudes toward higher education.

This paper describes the USC Faculty Model, a computer-based tool that can be used by policy makers to evaluate the effects of present and proposed policies on their institution's long-term future, and to find those policies that will result in shaping the composition of their faculty to meet the institution's objectives.

In brief, academic administrators can control four policy variables directly:

- hiring
- tenure
- promotion
- retirement

Hiring policy involves the timing and ranks and age mix of new faculty members. Tenure policy refers to the fraction of probationers granted tenure and the timing of the tenure decision. Promotion involves issues such as length of time in grade. Retirement policy includes the use of

mandatory age criteria and the possibilities of early and late retirement. Each of these policy variables affects both the mix of faculty on campus and the finances of the institution.

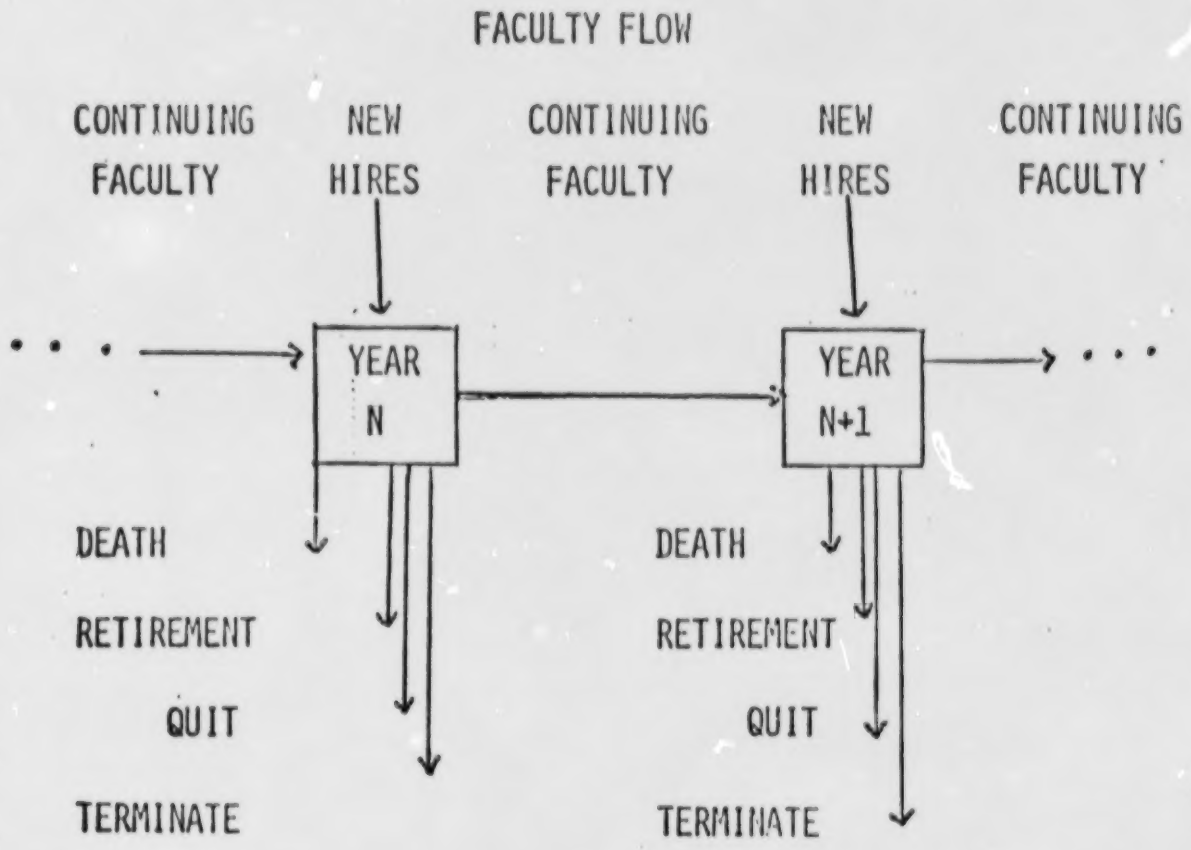
To make intelligent choices among alternative policies and thereby manage the future, policy makers must know the long-term implications of their decisions. The USC Faculty Model permits exploring the effects of these policy variables, individually and in combination, on the characteristic of a faculty over a period of up to 20 years.

POLICY ANALYSIS

As shown in Figure 1, next year's faculty is the same as this year's faculty except for the addition of new hires and the loss through attrition. Losses result from death and resignation (uncontrollable) and retirement and tenure denial (controllable). For a faculty of constant size, for example, the number of new hires that can be made in the following year depends completely on the losses in the previous year.

Policy analysis is, of course, concerned with more than just extrapolating present trends. Its objective is to define policies that will result in transforming this year's faculty mix into a desired mix of faculty to meet future needs. The faculty mix is typically evaluated in terms of rank and age distribution, percent faculty tenured, and expected costs. Opportunities for influencing the future come from the number of vacant positions to be filled. Because the exact future that will result from a given set of policies is uncertain, it is of interest to know not only the average outcomes from that policy, but also the <u>range</u> of situations that can be anticipated.

FIGURE 1



HIRES = NEXT YEAR'S REQT'S - CONTINUING FACULTY + TERMINATIONS

NEXT YEAR'S FACULTY = CONTINUING FACULTY + HIRES - TERMINATIONS

THE MODEL

The model is described in detail in Appendix A of this paper. In brief, the model is cohort oriented. That is, it begins with information about the characteristics (rank, age, salary, tenure status) of each current faculty member. It then traces individuals year by year into the future. It uses policies, typically specified in terms of probabilities, to determine retirements, tenures, and promotions. Actuarial probabilities by age are used to determine deaths. Resignations are based on historical or anticipated rates in each rank. Vacancies are filled according to a hiring policy that can depend on the rank of faculty who leave and on the desired age, rank, and tenure status of replacements. The total size of the faculty anticipated to be required year by year can be varied. Faculty costs are estimated in constant dollar terms based on the ranks and ages of the individuals in the cohort. As shown in Appendix A, it has been found that salaries can be closely approximated for each rank by fitting 3 straight lines as a function of ages. These linear curves correspond to high, medium, and low paid individuals.

To provide a tool for exploring the implications of policy alternatives and to aid in the selection of desirable policies, the USC Faculty Model operates in an interactive mode. A standard policy is presented to the user (say, a Dean) who can, by responding to a series of standard questions, change any of the policy variables and many of the other variables, such as anticipated resignation rates. Since the model simulates events that will occur in the future, a number of replications are required to obtain statistically meaningful averages that represent expected outcomes. Individual replications provide a "scenario", that is, one possible outcome. Data are provided by the model on the expected outcome and the range of possible outcomes for a given policy for each year over the time horizon.

FIRST EXPLORATION: BENIGN, CONSERVATIVE, AND DRACONIAN POLICIES

To illustrate the uses of the model, consider the result of sample runs made under the assumption of constant faculty size over 10 years. Three policies, which we have arbitrarily labeled "benign", "conservative", and "draconian" were assumed. These policies are defined in Table 1. The conservative policy is based roughly on historical experience of one of the professional schools at the University of Southern California. As indicated in Table 1, this school has tenured 25% of its Assistant Professors and has experienced an annual turnover of 10.5% in this rank. Associate professors have had an 8% chance of being promoted to full professor during each of the first 2 years after tenure and a 15% chance thereafter. No one has been promoted to full professor if more than 10 years in rank or over 45. Retirement takes place at 65. Replacements are principally at the Assistant level, but a significant number of senior appointments are made.

In the benign policy, tenure becomes highly likely (75%) which, it is assumed, reduces the turnover from 10.5% to 5% per year. Promotions to full professor are more rapid and have few restrictions. Replacements are typically made at the same level or higher level.

In the draconian policy, on the other hand, the situation is reversed. Tenure is awarded in only 10% of the cases, which results in a 15% annual turnover of Assistant Professors. Those appointed at associate or full rank are not assured tenure. Resignations at these ranks are assumed to increase slightly in response to the less pleasant environment. Early retirement is encouraged and replacements are almost exclusively at the Assistant level.

The purpose, then, was to explore how well the present policy does and to explore the effects of "soft" or "hard" environments on the future of 3 different schools having between 100 and 140 faculty members. The results obtained

TABLE 1

DEFINITION OF BENIGN, CONSERVATIVE, AND DRACONIAN POLICIES

Policy Variable	Rank	Benign Policy				Conservative Policy				Draconian Policy			
Probability of TENURE	Professor	1				1				0.8			
	Assoc. Professor	1				1				0.8			
	Asst. Professor	0.75				0.25				0.10			
Probability of QUITTING in any year	Professor	0.025				0.025				0.04			
	Assoc. Professor	0.02				0.02				0.04			
	Asst. Professor	0.05				0.105				0.15			
		P	AP	aP	I	P	AP	aP	I	P	AP	aP	I
REPLACEMENT of Vacancies	Professor	1	-	-	-	.25	.15	.60	-	.1	-	.9	-
	Assoc. Professor	.3	.7	-	-	.10	.25	.65	-	-	.1	.9	-
	Asst. Professor	-	.25	.75	-	.01	.05	.94	-	-	-	1.0	-
	Instructor	-	-	-	1	-	-	-	1	-	-	-	1
RETIREMENT		Retire at 65				Retire at 65				Early retirement possible.[1] Mandatory at 65.			
PROMOTION from Associate to Full Professor	Max No. of Years in Rank	20				10				7			
	Max Age	65				45				45			
	Probability of Promotion each year	.25				.08 year 1, 2 after tenure; .15 thereafter				.05			

[1] In technical terms, the probability of retiring at any age between 60 and 64 is .20, if not retired previous to that age.

for school "B" are plotted in Figure 2. Four sets of data are shown in Figure 2:

- percent faculty tenured
- average faculty age
- average faculty salary (constant 1974-75 dollars)
- total number of positions opened.

In interpreting the plot of number of opening, it should be recognized that the numbers are cumulative over the years and represent the number of people hired rather than the number of the initial faculty who leave. Thus some positions become open and are filled several times during a ten-year period.

Tables 2 and 3 show the expected distributions of ranks, the expected number of retirements, and the potential spread of each of the four variables in 1984-85 for the three schools. Data are presented for all three policies and present values are recorded for comparison. The data in Table 2 are averages of 5 runs. In Table 3, the lowest and highest value observed in 5 runs are listed together with the average of these 5 runs to indicate the range of outcomes that can be anticipated.

A few comments are in order about the results. Figure 2 refers specifically to School B; however the trends are similar for the other two schools considered. First, the "conservative" policy does quite well in creating a sizeable number of new positions, keeping the faculty from aging, and keeping costs relatively level in constant dollar terms. The policy actually reduces the fraction tenured by 8%, mostly because 13 retirements are anticipated. A draconian policy, if it were applied, would reduce faculty age and salary costs, and would create an average of 6 more openings per year. As is to be expected, a benign policy has the opposite effect since more of the present faculty stay. Therefore, there are fewer hiring opportunities, and the average age, percent tenured, and cost/faculty all increase. Almost the entire faculty become

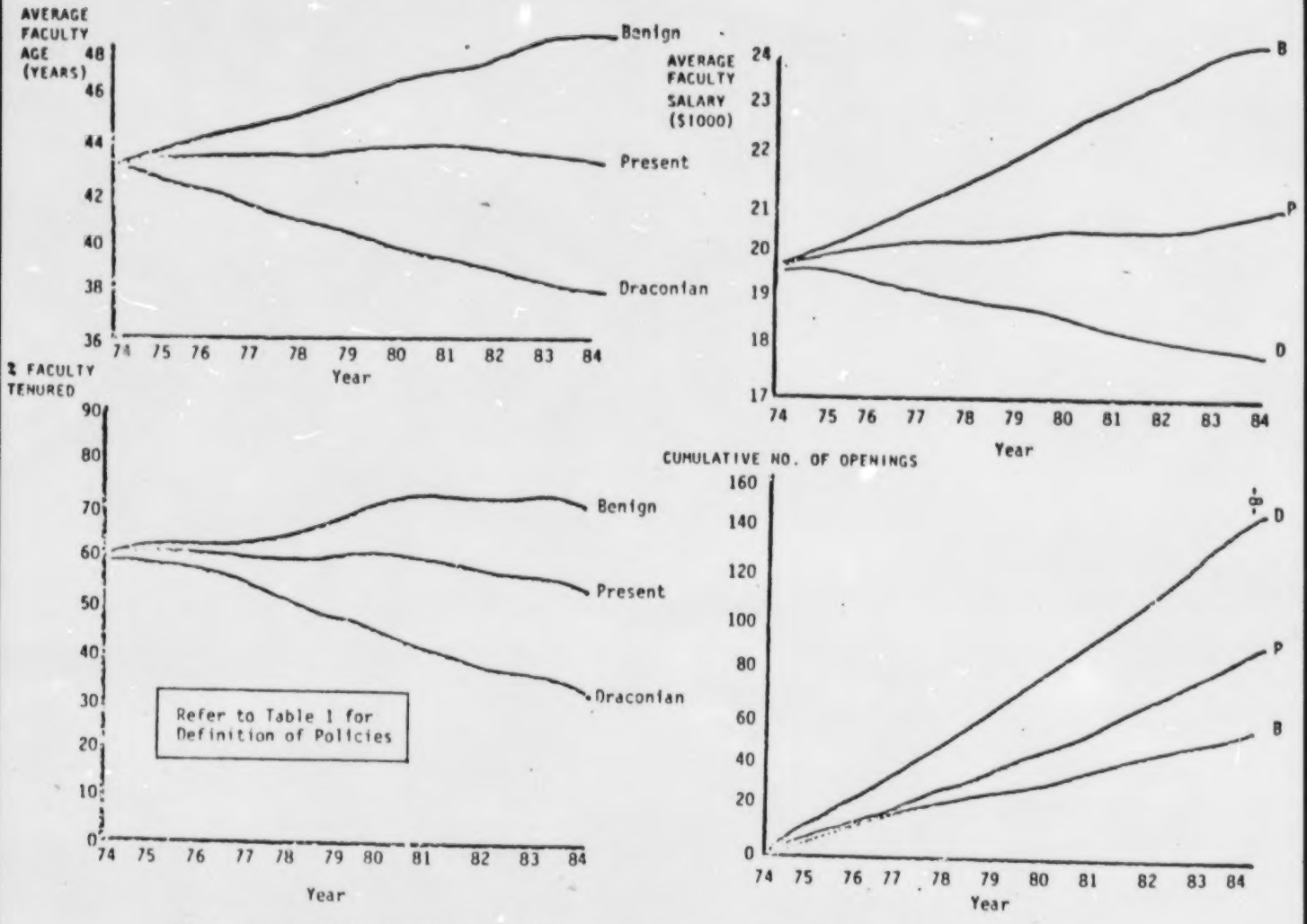


Figure 2: ANTICIPATED FACULTY COMPOSITION UNDER THREE POLICIES, SCHOOL "B"

TABLE 2

EXPECTED RANK DISTRIBUTIONS AND

RETIREMENTS BY 1984-85

SCHOOL	RANK	RANK DISTRIBUTION 1984-85			
		1974-5	Benign Policy	Conservative Policy	Draconian Policy
A	Professor	26	81	31	13
	Associate Prof.	39	8	30	23
	Asst. Prof.	27	3	31	56
B	Professor	53	94	51	27
	Assoc. Prof.	26	9	18	12
	Asst. Prof.	29	5	39	67
C	Professor	48	109	50	13
	Assoc. Prof.	32	11	26	22
	Asst. Prof.	49	9	52	84

CUMULATIVE NO. OF RETIREMENTS

1975-84

SCHOOL	Benign Policy	Conservative Policy	Draconian Policy
A	11	12	13
B	12	13	18
C	10	11	14

TABLE 3

RANGE OF VARIABLES IN 1984-85

School	Variable	1974-75 Actual	Benign			Conservative			Draconian		
			Low	Avg	High	Low	Avg	High	Low	Avg	High
A	Total # of Openings		40	44.6	48	67	82	91	122	128	133
	Total Faculty Cost	1872	2298	2310	2349	1904	1956	2021	1728	1766	1801
	Avg Faculty Age	43.3	48.7	49.1	49.5	47.4	43.3	44.4	37.5	38.6	39.4
	% Tenured	55.0	71.0	75.2	79.0	51.0	56.2	63.0	29.0	34.2	37.0
B	Total # of Openings		51	54	62	81	86	91	132	144	152
	Total Faculty Cost	2220	2740	2751	2774	2301	2348	2374	1936	2017	2090
	Avg Faculty Age	43.1	48.2	48.4	48.6	42.6	43.2	43.9	36.9	37.7	30.1
	% Tenured	61.2	68.1	72.0	76.1	50.4	53.6	56.6	25.7	31.7	39.8
C	Total # of Openings		52	61	70	112	116	119	165	179	181
	Total Faculty Cost	2416	2912	2951	2976	2414	2446	2494	2082	2132	2207
	Avg Faculty Age	40.9	45.9	46.4	47.0	40.6	40.9	41.7	36.2	37.1	38.1
	% Tenured	53.0	68.6	73.3	75.7	46.4	49.9	52.9	30.0	32.1	34.3

Notes:

Total No. of Openings are cumulative between 1975-76 and 1984-85

Faculty Cost in thousands of dollars

Based on data from 5 replications

Faculty sizes are:

School A 100
School B 113
School C 140

full professors. The cost increases are quite significant for a 10-year horizon. For example, the total cost for faculty salaries in School B would increase by $530,000 in constant dollar terms.

Early retirement, which is introduced in the Draconian policy, generates few additional openings. However, it does have a significant effect on the timing of retirements. In School B for example, the retire at 65 policy would lead to 4 retirements before 1980 and 9 thereafter. The particular early retirement policy specified results in 8 retirements before 1980 and 10 thereafter. In each case the principal effect of instituting early retirement appears to be that a few additional positions become vacant in the immediate future but thereafter, the system is in equilibrium and no additional gain in additional positions is obtained.

SECOND EXPLORATION: SENSITIVITY ANALYSIS

In this second exploration, the conditions of the conservative policy (Table 1) were used as a reference case inasmuch as this policy appears suitable for achieving stability in steady-state staffing. The objective of this second exploration was to determine the relative importance of individual policy variables.

The variables considered were (Table 4):

- probability of TENURE for Assistant professors (10% to 100%) and senior appointees (80% to 100%)
- PROMOTION from Associate to Full Professor (few to most)
- REPLACEMENT of vacancies (all at same rank; all by assistant professors)
- Early RETIREMENT (mandatory at 60 or 62)
- Probability of RESIGNATION (none to quadruple reference run).

The last variable is not strictly a policy variable since it can be controlled only indirectly by academic administrators.

TABLE 4

SUMMARY OF SENSITIVITY RUNS

Policy Variable	CASE	Values
Probability of Tenure for Assistant Professors		.1 .25 .75 1.0
Tenure Probability for Associate and Full Professors		1 .5
Replacement Policy		REFERENCE RUN values
	A	All openings filled by the same rank
	B	All openings filled with Assistant Professors

Promotion Policy from Associate to Full Professor		Annual Probability of Promotion	Maximum Age	Maximum No. Years after Tenure
	A	.05	45	12
		.15*	45	12
	B	.25	45	12
	C	.15*	65	20

Resignation Probability (annual)		Full	Associate	Assistant
	A	0	0	0
		.025	.02	.105
	B	.025	.02	.21
	C	.10	.08	.21

Retirement	Mandatory at 65
	Mandatory at 62 (those currently 62 or over at 65)
	Mandatory at 60 (those currently 60 or over at 65)

Notes: School B

CASE references are used in Table 5

REFERENCE RUN values are underscored and are those given in Table 2

*As in REFERENCE RUN, probability of promotion is .08 in first 2 years after tenure.

The results obtained for School B are summarized in Table 5. Based on these results, the following conclusions were drawn:

1. High tenure rates for assistant professors result in high total faculty tenure percentages and reduce the number of new openings significantly. In steady-state staffing, new initiatives can be undertaken only if vacancies occur. Maintaining high turnover among assistant professors is therefore important if the capacity for new initiatives is to be maintained.
2. Reducing the probability of tenure for senior appointees (i.e., individuals initially appointed as associate or full professors) and changing the promotion policy from associate to full professor appears to have marginal effect, at best.
3. A replacement policy that always fills vacancies with individuals at the same rank as the incumbent who left results in escalating salary costs and an aging faculty. Bringing young people in as senior faculty depart is essential; however, a policy in which all replacements are at the Assistant Professor level is probably extreme and generally not needed.
4. Policies that mandate early retirement (say at 60 or 62) for all faculty, even if they could be enforced, provide only a short-term increase in the number of openings. However, combined with conservative tenure policies and hiring predominantly at the Assistant Professor level, tenure percentages, average age, and total cost are reduced somewhat.
5. Resignation rates have a much more significant impact than many of the policy variables that can be controlled. If no one resigned and all probationary faculty stay for the full time allowed by AAUP

TABLE 5

RESULTS OF SENSITIVITY RUNS

Policy		Percent Faculty Tenured 1979	Percent Faculty Tenured 1984	Average Salary (1,000) 1979	Average Salary (1,000) 1984	Average Age 1979	Average Age 1984	Cumulative No. of new Hires by 1979	Cumulative No. of new Hires by 1984
Reference Run		58.9	52.6	20.6	20.8	43.8	43.2	43	87
% Tenure for Asst. Prof.	.10	57.1	49.9	20.2	20.7	43.4	43.1	45	92
	.50	64.3	58.8	20.5	21.1	44.1	43.9	35	74
	.75	66.8	62.4	20.7	21.4	44.5	44.4	31	65
	1.0	90.2	66.1	20.8	21.6	44.6	44.8	29	61
% Tenure for Assoc. Prof	Prof .5	56.9	49.0	20.2	20.5	43.1	42.5	47	98
Promotion to Professor	A	59.2	52.9	20.3	20.7	43.6	43.4	42	85
	B	59.2	51.4	20.4	20.8	43.5	43.1	43	88
	C	60.2	52.1	20.5	20.8	43.8	43.1	41	87
Replacement	Same Rank	59.9	58.6	21.0	22.4	44.7	45.8	40	81
	All Asst. Prof	58.4	44.3	20.0	19.6	42.9	41.0	44	98
Retirement	60	52.3	48.9	19.9	20.0	41.4	41.2	52	100
	62	54.2	46.8	20.0	20.0	42.1	41.5	48	97
Resignation	A	66.7	62.0	21.0	21.9	45.0	45.6	23	48
	B	59.6	48.8	20.5	20.5	43.7	42.7	52	116
	C	39.5	34.3	18.8	18.0	40.0	38.1	83	152

Notes: Policies are as defined in Table 4. A, B, C refer to Cases listed in Table 4.

[ ] = maximum influenceable by policy (excludes resignation)

( ) = minimum influenceable by policy (excludes resignation)

Based on School B

rules, the number of openings would be seriously reduced; conversely, if the resignation rates of Professors and Associate Professors were to double, significant numbers of additional openings would result.

In assessing the foregoing conclusions, it must be recalled that they are based on changes in one variable at a time and do not take into account synergysms that may exist. Some of the variations considered, such as mandatory retirement at 60, are neither likely nor desirable for a stable, healthy academic environment. However, it is striking that for a faculty of slightly over 100, the situation remained remarkably constant even under seemingly wide swings in individual variables.

THIRD EXPLORATION: EQUAL EMPLOYMENT OPPORTUNITIES

The current drive for equal employment opportunities for women has imposed requirements on universities and colleges to increase the representation of females on faculties. Historical data have been used to derive "availability pools." These pools represent the fraction of Ph.D.'s awarded to females since 1960. Like many schools, the proportion of female faculty at USC is below these availability pools. The purpose of this exploration was to determine what fraction of new hires would have to be female to bring the proportion of women up to pool levels.

In this exploration, runs were made for three schools: Social Sciences, Humanities, and Natural Sciences.[1] The availability pools for each school were determined by weighting the availability pools in each field by the fraction of total school faculty in that field.

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[1]These schools form the college of Liberal Arts and Sciences. They are not schools referred to as A, B, C earlier.

In obtaining data, the "conservative" policy given in Table 1 was assumed. The probability that a woman would be hired to fill each vacancy that occurred was varied between 0 and 100 percent. Figure 3 and Table 6 summarize the results. It is immediately evident that simply hiring in proportion to the availability pool, while improving USC's position, can never bring the percentage female at USC up to pool levels. The data show that a rate close to twice the availability pool would have to be used if such a goal were to be achieved in 10 years. The availability pool would be reached in 3 years if half of all hires were female.

The results present once again a conundrum that was nicely stated by Galbraith: what is an individual good may not be a common good. In this case, by hiring at twice the availability rate, USC would be able to reach a representation in proportion to the availability pool. However, by USC over-hiring from the pool, other institutions would find the supply of female Ph.D. reduced and they would not be able to meet similar goals. There is also an economic implication. If Federal standards require each institution to have a representation proportional to the availability pool, it would not be possible for all institutions to conform. In this effort to comply, however, institutions would compete in salary with one another, thereby escalating costs and creating internal imbalances within institutions.

FOURTH EXPLORATION: EFFECT OF CHANGING FACULTY SIZE

In each of the first three explorations, the size of the faculty was assumed to remain constant over time and all openings are filled as they occur. The USC Faculty Model can be used to study the effects of varying faculty requirements on the institution. In this exploration, we present a discussion of how the model handles different scenarios of growth and decline.

Figure 3

EFFECT OF DIFFERENT FEMALE HIRING RATES ON FEMALE FACULTY REPRESENTATION

- - - Availability pool = 28%

School of Humanities

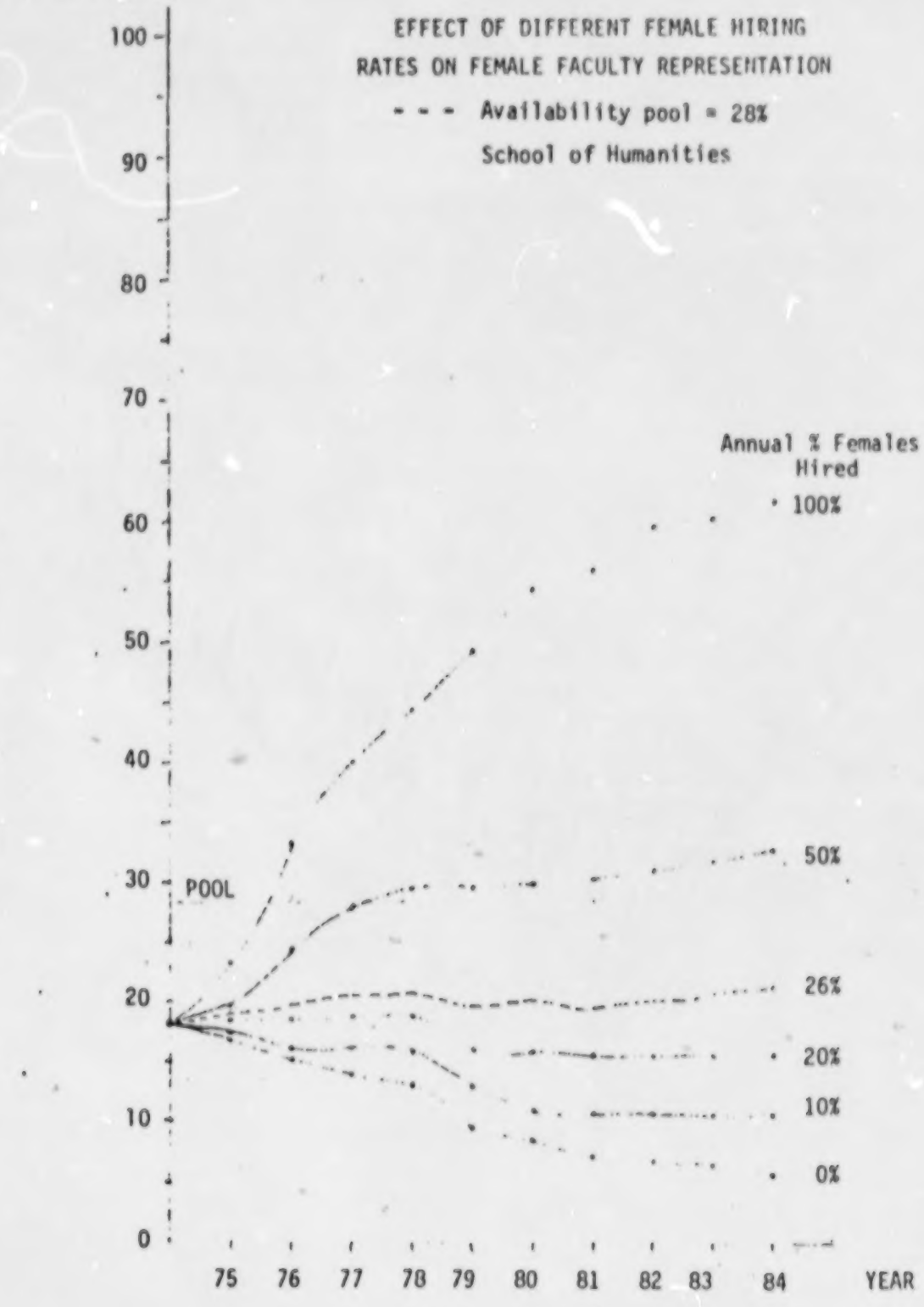

TABLE 6

HIRING RATES NEEDED TO REACH FEMALE AVAILABILITY

POOL LEVELS WITHIN 10 YEARS

FIELD	AVAILABILITY POOL (%)	CURRENT % FEMALE	% FEMALE; HIRING AT POOL RATE (1984)	NEEDED HIRING RATE
Social Sciences	15	11	13	20
Humanities	26	19	21	43
Natural Sciences	9	5	7	16

Notes: Based on USC Data

HIRING AT POOL RATE assumes that the the probability of hiring a female to fill a vacancy remains fixed at the availability pool percentage for the next ten years.

NEEDED HIRING RATE specifies the needed probability of hiring a female to fill each vacancy that occurs.

The model requires predictions of the size of the faculty, year by year, over the time horizon. In addition, it is possible to specify a goal of the percentage of full-time-equivalent (%FTE) positions that will be filled with part-time faculty (teaching assistants, adjunct professors, etc). In many disciplines, national accreditation bodies limit the percentage of positions that can be filled with such part timers. If a school does not want to commit to part-time faculty, it can specify a small percentage or even a goal of none.

The model is basically conservative. It fills vacancies with part-time faculty if:

- attrition occurs and the percentage of positions filled by part-timers is less than the goal.
- total full time faculty required in any year in the future is less than the number required in the year being considered.

In the second case, the purpose is to avoid over-hiring; thus, temporary increases in faculty are covered by part-time rather than full time faculty. The model is so arranged that it meets the requirements in the last year of the time horizon as closely as possible.

Figure 4 shows the results obtained from a series of predictions for faculty requirements for a school with 39 contract faculty at present. The term "contract" is used to refer to faculty teaching full time and FTE to the number of positions filled by part timers.

a. Constant Faculty Requirement, Desired % FTE = 0

This is the case run previously. The total faculty is constant and vacancies are filled by replacement as they occur.

b. Constant Faculty Requirement, Fixed % FTE

In this next simplest case, the number of faculty and the number of FTE both remain constant.

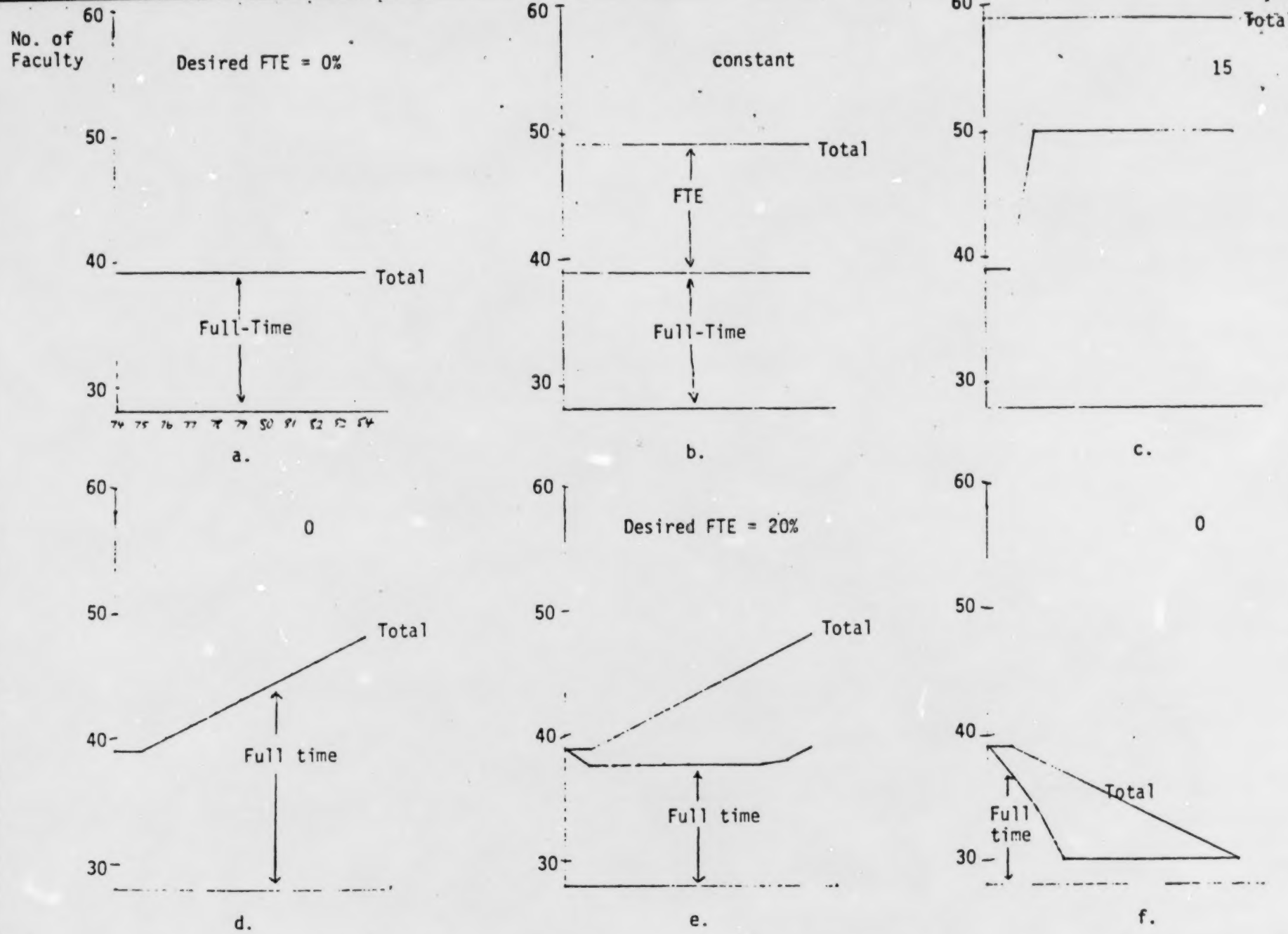

Figure 4: Effect of Different Faculty Requirements

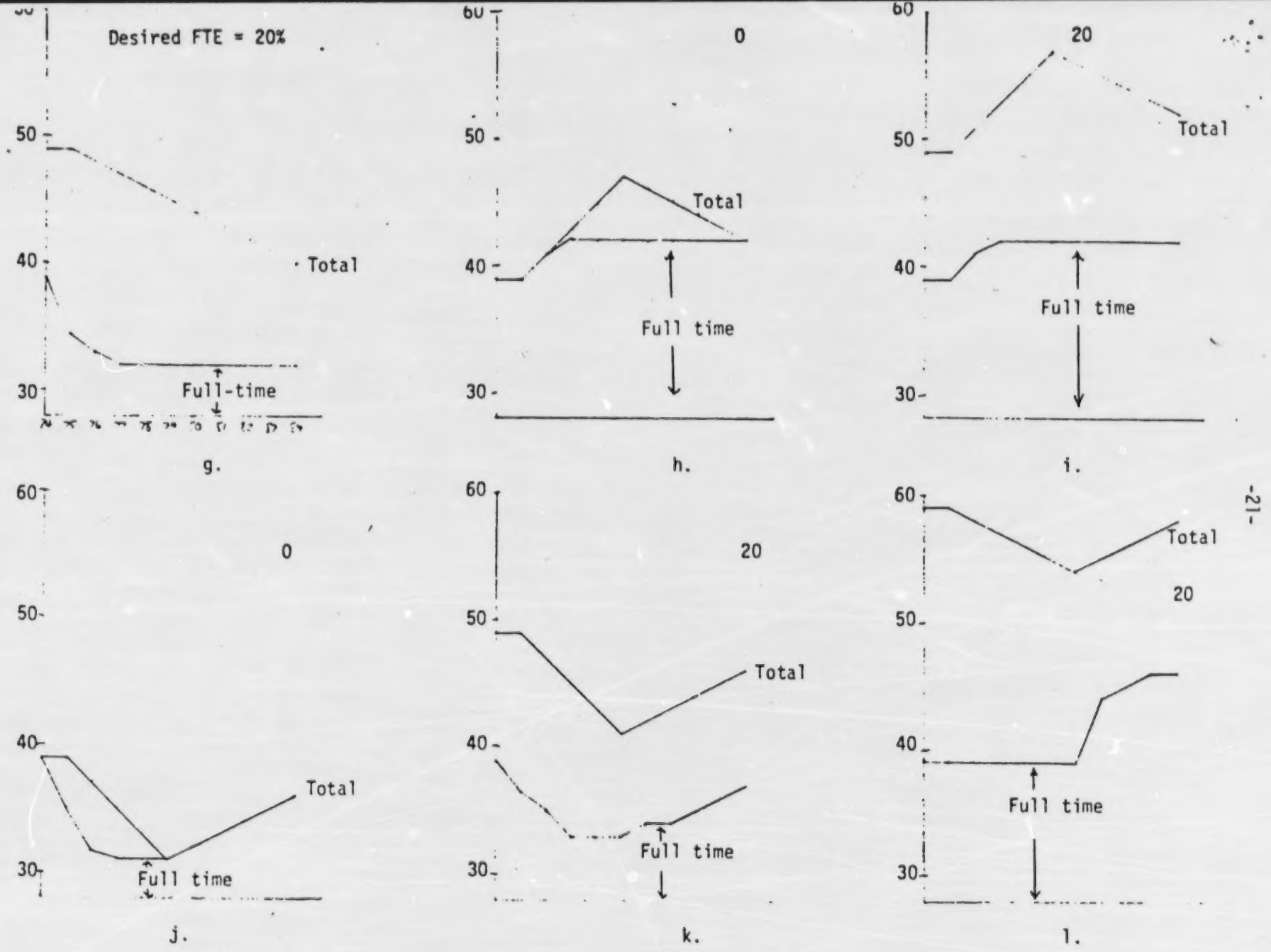

Figure 4 (continued)

c. Constant Faculty Requirement, % FTE Too Large Initially

Here the initial faculty consists of 39 plus 20 full-time equivalents. With a goal of only 15% FTE, the model immediately hires contract faculty to make up the deficit.

d. Increasing Faculty, 0% FTE

The contract faculty is expanded year by year to match increasing requirements.

e. Increasing Requirements, 20% FTE goal, no initial FTE

In the first year, where there is constant requirements, attrition is allowed. Thereafter, the contract faculty is kept constant, with growth achieved through use of hiring FTE's. When the 20% criterion is reached, the permanent faculty is increased.

f. Decreasing Requirements, 0% FTE

Attrition is permitted until the number of contract faculty equals the minimum anticipated over the time horizon. The gap is filled with temporary FTE's. When the minimum is reached, the contract faculty is kept constant. Reduced requirements are met by reducing the FTE staff.

g. Decreasing Requirements; 20% FTE

Attrition is permitted until the number of contract faculty equals 20% less than the minimum requirement, after which the faculty is kept constant. Note that in both cases f. and g. contract faculty are not hired until the worst condition is reached. This results in an excess of part-time faculty during the time horizon but balance is reached at the end of the horizon.

h. Increase Followed by Decrease; 0% FTE

Increasing requirements are followed until the contract faculty equals that at the end of the time horizon. The temporary peak is absorbed by using FTE's.

i. Increase Followed by Decrease; 20% FTE

Increasing requirements are followed until the contract faculty equals the end requirement less 20%.

j. Decrease Followed by Increase; 0% FTE

Attrition is permitted until the contract faculty is reduced to the minimum anticipated. The contract faculty is then kept constant at the minimum until growth commences. The growth is followed year by year.

k. Decrease Followed by Increase; 20% FTE

The initial faculty has 20% FTE. Attrition is permitted until the contract faculty equals the minimum less 20%, after which growth is followed with the %FTE kept fixed at 20%.

l. Decrease Followed by Increase; 20% FTE; Initial Faculty 33% FTE

During the decline period, the contract faculty is kept constant, thereby reducing the % FTE. When the minimum is reached, additional contract faculty are hired to reduce the % FTE to the desired level of 20%.

In summary, the model assumes a conservative policy on hiring contract faculty. If there is any anticipated decline in requirements, they are brought in to meet growth only to the extent that they are needed to meet criteria at the end of the time horizon.

From a policy point of view, since FTE's are paid only for teaching, the annual cost associated with each position filled by part-time faculty is much less than for contract faculty. This cost reduction is further enhanced by the lower fringe, travel, and office requirements of FTE's. Thus, a suitable strategy for a school in economic difficulty that now uses few part-timers (be they teaching assistants or outsiders) may be to deliberately replace departing faculty with FTE's.

The model has also been used to determine the rate of decline in demand which, if it were to occur, would be catastrophic. In these trials, the number of faculty required was assumed to decline by a constant amount (say 2, 5, 10,...per year) year after year starting either now or at some specified year in the future. Catastrophe was defined as the year in which existing faculty would have to be laid off because of a lack of demand.

USE AT DIFFERENT INSTITUTIONS

The USC Faculty Model was designed to be easily transportable for use at other institutions. The program is written in Basic and it runs on the PDP-10 computer. A version in Fortran is now available and experience is being accumulated using other computers.

The model is now at use in a number of liberal arts colleges with faculties of 50 to 200. It is also being used at large universities, with analysis on a school basis. No major problems have been encountered in using the model at other institutions. Some observations can be made:

1. The model requires a simple faculty data base (birthday, rank, salary, tenure year, sex, ethnicity, department). We have found that many institutions have not had this data base readily available in a central location. The collection of this data has been a valuable experience to those institutions who did not already have this central data base source.

2. To operate the model in a planning mode requires specification of a number of policies and practices (e.g. annual rates of promotion, tenuring, quitting, for all ranks; hiring and replacement by rank, salary and age; retirement policy and actual retirement experience; affirmative action planning - sex and ethnicity of new hires; salary increases each year; full-time and part-time faculty count and changes with time). Most institutions have not collected data on actual policy or practice in these areas. Recent historical data is useful in planning for the next decade. Since use of the model requires this input, its collection, study and the selection of various possible planning alternatives has been a very rewarding experience for the faculty and administrators who are working with

the USC Faculty Model. This exercise, required to use the USC Faculty Model, has been stated by several institutions as an important planning step independent of the use of the model.

3. The model can be used jointly by administrators and faculty committees, creating a common understanding of problem areas. This in turn can lead to concensus generation where new policies and practices are needed which may, at first, be viewed with hostility by some faculty.

APPENDIX A

DESCRIPTION OF THE USC FACULTY MODEL

An over-all view of the USC Faculty Model is shown in Figure A-1. The model has two sets of inputs, one set representing the present and anticipated environment and the other the policies to be followed. The model traces the faculty through the environment according to the policies specified and produces statistics on the implications of these policies over the time horizon.

Environmental Inputs

Faculty Data Bank - The name, age, rank, salary level (see below), sex, year of tenure or tenure decision, and department of each faculty member is stored in a data file. For a large university, separate data files are provided for each major school (e.g., Engineering, Humanities, Social Work).

Mortality Tables - Mortality tables for 1979 provided by TIAA are used. These tables specify the probability of a man's dying given the current age. A factor of .58 is used to correct for the longer life expectancy of females.

Salary Structure - Several methods for salary projection have been developed. The first method simulates a salary schedule with step progression to higher salaries with increasing years of experience. A special case is a three tier salary structure with annual increases for top performers, average performers and those below average. Any schedule may be represented, with flexibility in the number of steps.

The second method utilizes percentage increase for all faculty or a different percentage for each rank, or different age groups.

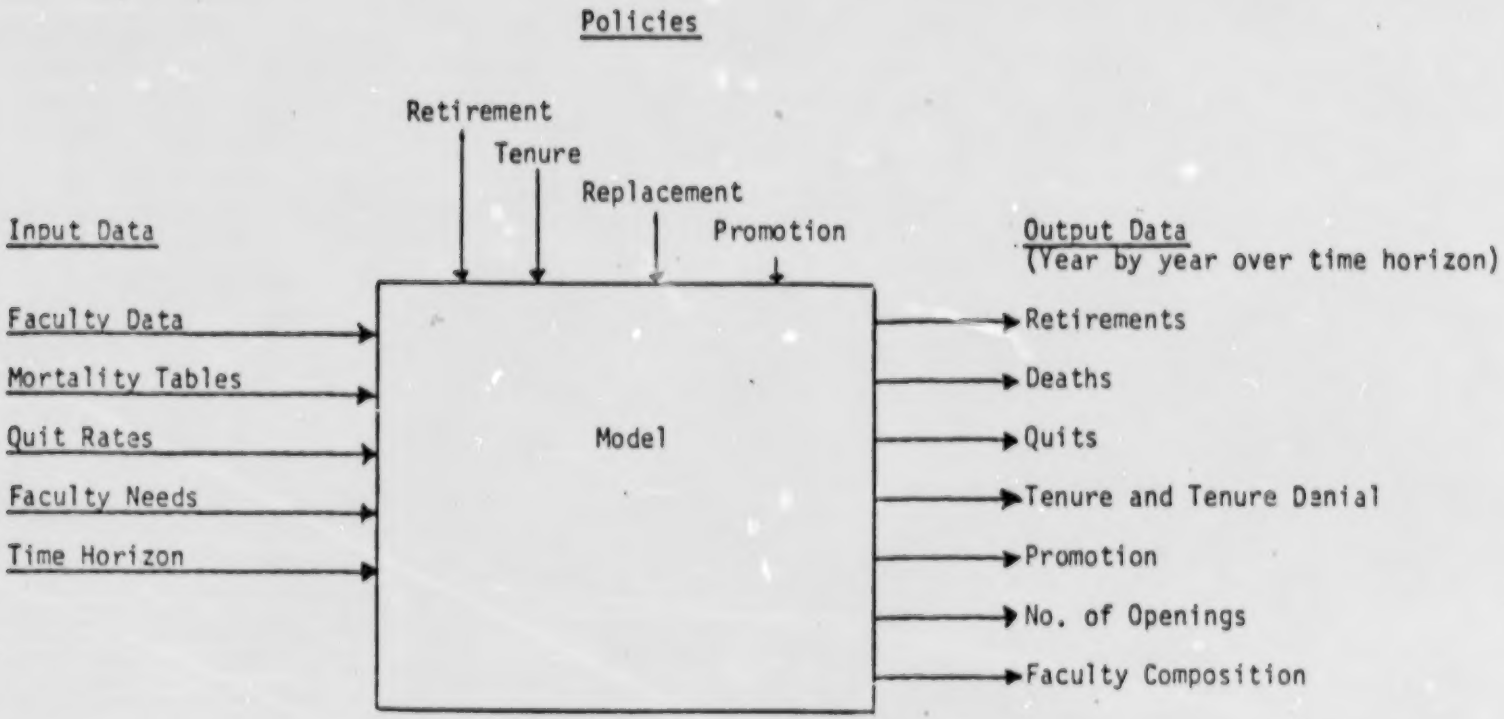

Figure A-1 Basic Structure of the USC Faculty Model

are discussed further in Appendix D.

-Resignation Rates. The resignation rate represents the average percentage of faculty in each rank who leave for reasons other than denial of tenure, death, or retirement. Typically, average historical experience over a 5 or 10 year period is used as a starting point for estimating these rates.

-Faculty Needs. The total faculty size can be assumed to remain constant over time or to vary. For a constant faculty, each faculty member who leaves is replaced. If there is growth or decline in total faculty, then the rules outlined in the Fourth Exploration (p. 16) are followed.

Time horizon - the number of years to be considered is typically set at 10; however, shorter or longer time horizons can be specified.

Policy Decisions

Retirement - Retirement policy is specified in terms of the probability of an individual retiring at a given age, given that they have not retired previously. At present, ages 60 through 65 are considered. A retire at 65 policy is specified as:

Age:	60	61	62	63	64	65
Probability of Retiring	0	0	0	0	0	1

A policy in which a substantial fraction of the faculty retire at 62 and 65 is mandatory might be expressed as:

Age:	60	61	62	63	64	65
Probability of Retiring:	.05	.05	.30	.10	.10	1

(Note that the cumulative probability of retiring between ages 60 and 64 in this policy is 48%).

Tenure - For each rank, the fraction of those eligible who are granted tenure is specified. It is assumed that the tenure decision is made in the 7th year and that those denied tenure leave the University. Average historical experience over the last 5 years can be used as a starting point.

Hires - As faculty in a given rank leave, they are replaced by new faculty whose rank follows a specified probability distribution. A typical hire policy for Associate Professors might be:

	Replace by			
Rank of Leaving Faculty	Professor	Associate Professor	Assistant Professor	Instructor
Associate Professor	.1	.3	.6	0

Note that the fractions in the row must sum to 1.

Promotion - Promotion from Associate Professor to Professor is specified in terms of the probability of promotion in a given year. Limits on promotion can be imposed, including minimum and maximum years after tenure and maximum age. Furthermore, a breakpoint can be specified; the promotion probability can be different before and after the breakpoint.

Output Statistics

The model provides data on the average number of:

- .retirements
- .quits
- .tenure denials and grants
- .promotions
- .deaths
- .positions available

in each year over the time horizon. It also provides data on the nature of the faculty, including average faculty age, salary (in constant dollars), rank distribution, and percent tenured.

In addition to providing information about average outcomes, the model provides data on the maximum and minimum values at the end of the time horizon for:

.total number of positions available

.total faculty costs

.faculty age

.percent tenured.

This information is designed to aid in understanding the range of outcomes that can be anticipated.

MODEL ORGANIZATION

The model traces the current faculty year by year, removing some because they leave the university and adding others who are hired. In this sense, the model is a fixed-time-interval simulation. A single run represents a particular outcome ("scenario") while the average of a number of runs represents the most likely outcome under a specific set of policies. The model uses a random number generator and the input probabilities to make decisions about each individual each year. Figure A-3 shows the over-all structure of the model. The paragraphs that follow describe how each decision is reached.

The program starts with the faculty as it exists in the current year. It examines faculty members one at a time. For each faculty member, it performs a series of tests.

Retirement: Is the faculty member over 60? If so, apply the retirement policy to determine whether he retires. If he does, replace him according to the replacement policy.

Death: Look up the faculty member's probability of dying in the mortality table. Determine if he dies. If so, replace.

Resignation: Check the faculty member's rank. Determine the probability of quitting this year. If he quits, replace.

Tenure: Is the present year the one in which the tenure decision must be made? If so, determine the probability of tenure for the faculty member's rank. If tenure is denied, replace. If tenure is granted an assistant professor, check promotion. If promoted change rank to associate professor.

For each year:

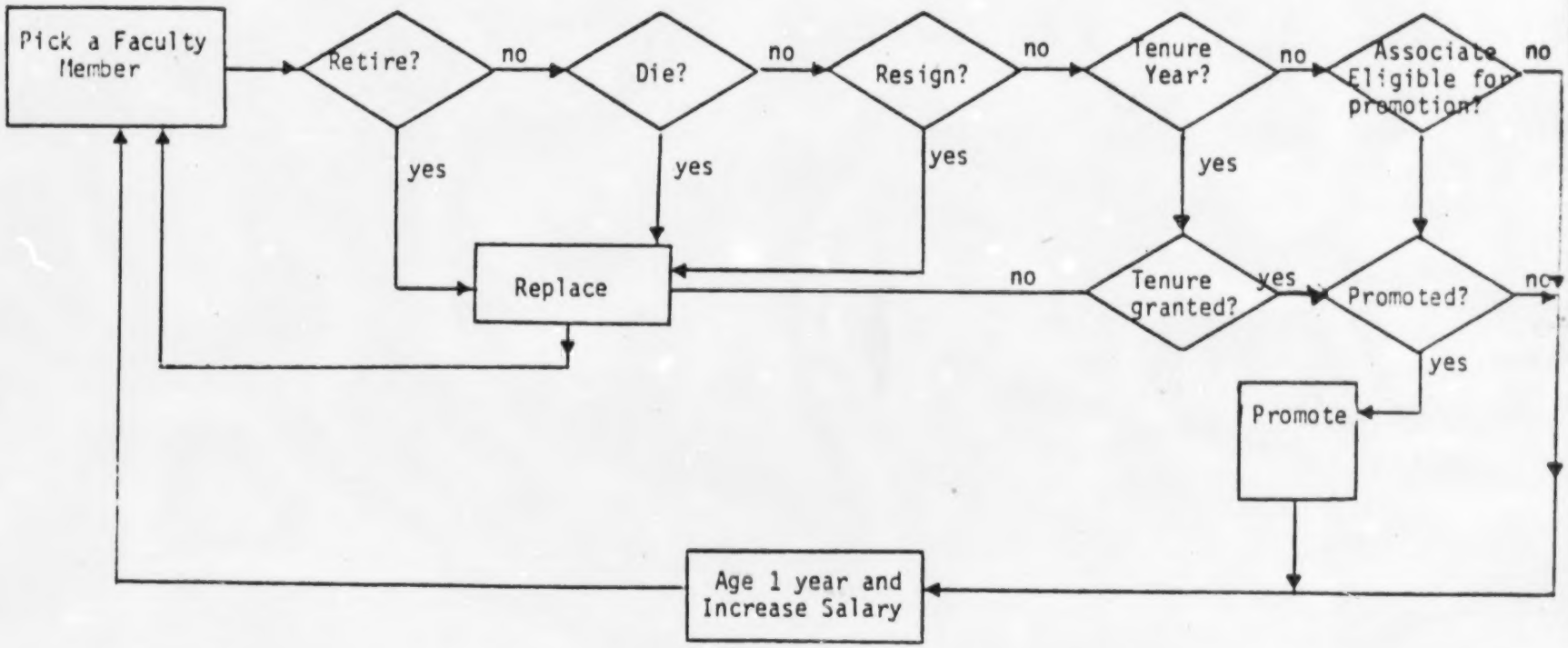

Figure A-4 Model Organization

Promotion: If the faculty member is an associate professor, determine whether he is eligible for promotion. If so, determine whether he is promoted or not. If promoted, change rank to full professor.

As a result of these tests, either a new faculty member is hired according to the replacement policy or the present faculty member is retained for another year. In the latter case, age is increased by one year and salary is increased according to the appropriate salary curve.

MODEL OPERATION

The model is coded in BASIC and is available on the USC PDP-10. The model operates in the interactive mode. To make a run, the user sits at a terminal and is asked by the program to specify the school, the time horizon, and the policy variables to be used. A standard set of values is provided. The user may vary any of the policy variables. Typical outputs which illustrate the interactive nature of the computer program are presented in Appendix C.

APPENDIX B

VALIDATION

One of the key issues in all simulations is the validity of the model. In the case of the USC Faculty Model, the purpose of the model is to predict 5 to 10 or 20 years into the future. Since it is, of course, not possible to test the model by waiting over such long futures, the alternative is to start with the situation sometime in the past and determine whether the model can predict the present.

The approach used was to begin with the School B faculty in 1969, and, based on the historical experience actually observed for various parameters (e.g., tenure rate, resignation rate), use the model to "predict" the 1974 faculty. The school had, remarkably, the same number of faculty in 1974 as in 1969 (although there were small variations in between). Table B-1 shows the results obtained, where the column labeled "Predicted" is based on model results and the column labeled "Actual" is based on data generated by the Office of Institutional Studies.

A few words are in order about the conditions used to achieve the match obtained. Initially, we used the data in the conservative case described in Table 1. These values gave poor comparisons, particularly for the distribution of ranks. We therefore went back into the historical data of the events from 1969 to 1974 to see whether these estimates were right. In doing so, we found several differences between the data and the conservative values (see Table B-2). Specifically, we found that six assistant professors had been transferred from faculty to research status. These individuals were therefore added to the "resign" group, raising the probability of resignation for assistant professors from 10.5% to 14.3%. Similarly we found slight underestimates in resignation rate for professors and associate

TABLE B-1

COMPARISON OF "PREDICTED" AND ACTUAL FACULTY CHARACTERISTICS

CHARACTERISTIC	PREDICTED 1974	ACTUAL 1974
No. of Professors	52	53
No. of Associate Professors	28	26
No. of Assistant Professors	28	29
No. of Instructors	5	5
Percent Tenured	60.6	61.0
Average Faculty Age	43.3	43.1
Total No. of New Hires 1969-74	43	55
No. of 1969 Faculty Still at USC in 1974	75	69
Total No. Granted Tenure (includes all ranks)	17	22
No. Promoted	18	16
No. Retired	3	3
No. Denied Tenure	9	13
No. Resignations	31	38
No. Deaths	.2	1

Based on 1969 to 1974 expense School B

TABLE B-2

COMPARISON OF "CONSERVATIVE" POLICY AND ACTUAL EXPERIENCE OF SCHOOL "b" 1969-74

POLICY VARIABLE	RANK	ACTUAL EXPERIENCE 1969-74	CONSERVATIVE CASE VALUE (from Table 1)
Probability of Tenure	Professor	1	1
	Associate	1	1
	Assistant	.25	.25
Promotion from Associate Professor to Professor	Maximum No. of Years after Tenure	12	12
	Maximum Age	45	45
	Probability of Promotion		
	First 2 years	.1	.08
	Years 3 to 12	.25	.15

Replacement of Vacancies		P	AP	aP	P	AP	aP
	Professor	.83	.17	0	.25	.15	.6
	Associate	0	1	0	.1	.25	.65
	Assistant	0	.05	.95	.01	.05	94

Average Age of Replacement	Professor	45	45
	Associate	35	35
	Assistant	31	27
Probability of Resignation	Professor	.035	.025
	Associate	.025	.02
	Assistant	.143	.105
Retirement	All ranks	65	65
Years to Tenure	Professor		4
	Associate		4
	Assistant		7

professors. Second, we examined the appointments that had been made between 1969 and 1974. We found that 12 professors, 6 associate professors, and 37 assistant professor positions had become vacant, but we also found that 10 processors, 9 associate professors and 36 assistant professors had been appointed. We concluded that the values for the conservative case assumed much lower ranks for replacements than actually occurred. The replacement table was revised accordingly. In examining promotions from associate professor to professor, we found that it was indeed true that those over 5, or more than 12 years in rank, were not being promoted. However, these constraints imply that the promotable group is only a subset of the associate professors and hence that the probability of promotion was being underestimated for those eligible. Age at hire of Assistant professors averaged 31 rather than 27 assumed in the conservative case.

Examination of the results in Table B-1 shows that the model underestimates the number of openings and the number of grants of tenure. We believe that these underestimates are due to two factors: (1) the granting of tenure earlier than the 7 years assumed for assistant professors and 4 years assumed for senior ranks (for example, four full professors were hired and received tenure within one year from appointment), and (2) the fact that the total number of faculty was not constant during this time; actual full-time faculty were:

1969	1970	1971	1972	1973	1974
113	113	118	114	107	113.

We believe that the comparisons in Table B-1 are satisfactory and give reasonable faith in the model. In evaluating these comparisons, however, it should be recognized that the actual data has been used twice, once in generating the parameters for the model and then in the comparison. Thus, if the results had

shown wide divergence, it would be reasonable to reject the model. The agreement obtained is a necessary condition but may not be a sufficient condition for accepting the ability of the model to predict.

APPENDIX C

SAMPLE OUTPUT

The following pages show sample output from the USC Faculty Model. Two sets of output are shown:

- a reference run for the conservative case in which no changes are made
- a 20-year run where each of the options available to users on-line are demonstrated.

It is the purpose of this appendix to explain the meaning of each of the outputs and options available. The data shown are for a faculty of 39 and are the average of two replications.

REFERENCE RUN

# of Iterations Requested	A required input. Indicates the no. of trials to be used for averaging. Increasing the number of trials reduces variability but increases cost.
INPUT DATA:	
Current Faculty	Lists the number in each rank, the number tenured, the number of males, females, and minorities.
Current Faculty Cost	Total annual cost of entire faculty in thousands of dollars
Average Faculty Age	Average age of faculty in the initial year
Initial Age Distribution	Gives the distribution of ages of the initial faculty by rank in 5-year age intervals.
RESULTS:	
Retirement Statistics	Lists the average number of retirees by the age at retirement during the entire time horizon
Faculty Changes	Gives for each year in the time horizon, the average number of: .quits (resignations) .deaths .faculty denied tenure .retirements .faculty granted tenure .faculty promoted .initial faculty who have departed .cumulative number of full-time faculty hired Note that the cumulative number of hires will be greater than the number of original faculty departing as specific positions may turn over more than once.

Faculty Data

This section gives data on the expected average year by year. Information is presented on:

- .number of professors
- .number of associate professors
- .number of assistant professors
- .number of instructors
- .number of full-time equivalent (FTE) faculty positions filled by part-time appointments
- .total faculty required (multiply number shown by 10)
- .average faculty age in years
- .average annual salary (in thousands) of individual full-time faculty members (constant dollars)
- .average total cost in hundreds of thousands of dollars for all faculty (full-time plus full-time equivalent) (constant dollars)
- .percent faculty tenured
- .percent female faculty members
- .percent minority faculty members
- .percent faculty positions filled by full-time equivalents

Expected # Original Profs by Dept. Remaining at School

Shows, year by year, the number of the initial faculty anticipated to remain in each department.

Expected # Cum. Openings by Dept. Each Year

Shows, year by year, the cumulative number of openings expected by each department

Range of Values

This table shows the minimum, maximum, and average values observed during the simulation for each of four faculty variables:

- .Cumulative number of hires over the time horizon
- .Anticipated total faculty cost in thousands of 1974 dollars
- .Average faculty age at the end of the time horizon
- .Percent faculty tenured at the end of the time horizon

Age distribution

The age distribution, by rank, is shown at 5-year intervals over the planning horizon.

ANALYSIS RUN

In this run, the data format for the initial faculty data and results is the same as in the reference run. The output shown demonstrates the policy options available for analysis. For each option, typing a 'Y' results in the computer indicating the standard value and requesting a changed value. If the standard value is adequate, it can be typed in as the reply; otherwise the changed value should be given.

# Iterations Requested	A required input.
Planning Horizon	User can change starting year and length of planning horizon. The maximum available horizon is 20 years.
Retirement Policy	User can change both the range of retirement ages (allowing early and/or late retirement) and the probability of retiring at a particular age, given retirement has not occurred previously. The computer automatically sets the probability of retirement to 1 (certainty) at the maximum age.
Initial Data Probabilities	The probability of resignation (quit), and the probability of being granted tenure when eligible can be varied by rank.
Replacement Probabilities	The user may vary the mix of ranks used to replace faculty who depart. The user must make sure that the probabilities of replacement associated with each rank (i.e., horizontally in each row) add up to 1.
Faculty Characteristics	The average age, salary level, and number of years to tenure decision for each new hire may be varied by rank. Salary is given in terms of 3 levels, where level 1 denotes high salary, level 2 average salary, and 3 low salary. All replacements at a given rank will be hired at the same salary level.
Promotion Policy	Promotion is divided into 3 sections. The first section deals with the rules and constraints for promoting associate professors to professor. Upper limits can be placed on the number of years past tenure and the maximum age for promotion. Two probabilities can be assigned, one for promotion immediately after tenure, and one for later promotion. The probabilities refer to the probability of promotion each year rather than cumulative probability.*

*An annual probability of promotion of .25, for example, would imply 25% chance of promotion within one year, (.75) × (.25) + (.25) = 43.75% probability of promotion within two years, 58.2% within 3 years, 68.6% within 4 years, etc.

	For assistant professors, it is possible to separate the tenure and promotion decision. Assistant professors can be promoted to associate without changing their tenure status and may be kept at the assistant levels even if tenured. Instructors may be promoted to assistant professors.
Female and Minority Hires	The program assumes that the percentage females and minority hired will be equal to the initial percentage of these groups unless a change is indicated.
Faculty Requirements	The user can specify the total number of faculty required year by year in the time horizon. The computer follows rules designed to meet these requirements. The user can also control the costs associated with part-time faculty by specifying the cost of one full-time equivalent. Finally, the user can specify the distribution of ranks of hires made to increase the faculty size if expansion is anticipated.

All entries that follow are in the same form as for the reference run.

USC 16:10 12-SEP-75

FILES: USCFIL, FACFIL

ITERATIONS REQUESTED ?2

PLANNING HORIZON: ANY CHANGES (Y OR N) ?N

RETIREMENT POLICY: ANY CHANGES ?N

INITIAL DATA PROBABILITIES: ANY CHANGES ?N

PROMOTION POLICY: ANY CHANGES ?N

% FEMALES HIRED / % MINORITIES HIRED: ANY CHANGES ?N

FACULTY REQUIREMENTS: ANY CHANGES ?N

INITIAL FACULTY DATA:

CURRENT FACULTY	TOTAL	TENURED	MALE	FEMALE	MINORITY
FULL PROF.	7	6	6	1	0
ASSC PROF.	11	10	10	1	1
ASST PROF.	14	2	11	3	0
INSTRUCTOR	7	0	3	4	2
ALL RANKS	39	18	30	9	3

CURRENT FACULTY COST (1000'S) = $ 638.7
AVERAGE FACULTY AGE (YEARS) = 41.5

INITIAL AGE DISTRIBUTION:

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	0.0	1.0	0.0	2.0	3.0	1.0	0.0	0.0
ASSC PROF.	0.0	0.0	2.0	1.0	1.0	4.0	1.0	1.0	1.0	0.0	0.0
ASST PROF.	0.0	1.0	6.0	5.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	4.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALL RANKS	0.0	5.0	10.0	7.0	4.0	4.0	3.0	4.0	2.0	0.0	0.0

RESULTS:

RETIREMENT STATISTICS:

RETIREMENT AGE:	60	61	62	63	64	65
AVG. # RETIRED:	0	0	0	0	0	5

FACULTY CHANGES:

	75	76	77	78	79	80	81	82	83	84
AVG. NO. OF QUITS	1.5	1.5	0.5	2.0	2.0	1.0	2.0	3.0	1.0	1.5
AVG. NO. OF DEATHS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5
AVG. DENIED TENURE	0.0	0.5	3.0	1.5	2.5	0.0	0.0	0.5	1.5	1.5
AVG. NO. RETIREMENTS	0.0	0.0	1.0	0.0	1.0	1.5	0.5	0.0	0.0	1.0
AVG. NO. TENURED	0.0	2.5	0.5	0.5	0.5	0.0	0.5	0.0	0.0	0.0
AVG. NO. PROMOTED	0.0	1.5	0.5	1.5	1.0	1.0	0.0	0.5	0.0	0.0
ORIG. FAC. DEPARTING	1.5	3.0	7.5	10.0	14.0	15.5	16.0	16.5	17.0	19.0
CUM. NO. HIRES	1.5	3.5	8.0	11.5	17.0	19.5	22.0	25.5	28.0	32.5

FACULTY DATA:

	75	76	77	78	79	80	81	82	83	84
AVG. NO. PROF.	7.0	8.0	8.0	9.0	8.0	8.0	8.0	8.5	8.5	7.5
AVG. NO. ASSOC.	10.5	10.0	10.0	9.5	9.5	8.5	8.0	7.5	7.0	6.5
AVG. NO. ASST.	14.5	14.0	14.0	13.5	14.5	15.5	16.0	16.0	16.5	18.0
AVG. NO. INST.	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
AVG. NO. F.T.E.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FAC. REQ'D. (10'S)	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9	3.9
AVG. FACULTY AGE	41.8	42.3	41.2	41.4	40.1	39.8	40.1	40.6	40.9	40.0
AVG. SALARY (1000'S)	16.5	16.8	16.7	16.8	16.2	15.8	15.9	16.0	16.1	15.6
AVG. COST (100K'S)	6.4	6.5	6.5	6.6	6.3	6.2	6.2	6.3	6.3	6.1
AVG. % FAC. TENURED	43.6	48.7	47.4	48.7	46.2	42.3	42.3	41.0	39.7	34.6
AVG. % FEMALE	21.8	19.2	20.5	21.8	25.6	26.9	25.6	25.6	25.6	26.9
AVG. % MINORITY	7.7	7.7	9.0	9.0	9.0	9.0	7.7	9.0	7.7	7.7
AVG. % F.T.E.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

BASED ON AVERAGE OF 2 ITERATIONS

EXPECTED # ORIGINAL PROFS BY DEPT. REMAINING AT SCHOOL:

DEPT.	74	75	76	77	78	79	80	81	82	83	84
1	21.0	20.5	20.5	17.5	15.0	13.0	12.0	11.5	11.0	10.5	10.0
2	18.0	17.0	15.5	14.0	14.0	12.0	11.5	11.5	11.5	11.5	10.0

EXPECTED # CUM. OPENINGS BY DEPT. EACH YEAR:

DEPT.	75	76	77	78	79	80	81	82	83	84
1	0.5	1.0	4.0	7.0	10.5	12.0	13.5	15.5	17.0	18.0
2	1.0	2.5	4.0	4.5	6.5	7.5	8.5	10.0	11.0	14.5

	TOTAL FAC. HIRED OVER 10 YRS.	FAC. COST (1000'S) IN 84 - 85	AVG. FAC. AGE IN 84 - 85	% FAC. TENURED IN 84 - 85
MIN.	31.0	602.0	39.6	33.3
MEAN	32.5	608.0	40.0	34.6
MAX.	34.0	614.0	40.4	35.9

AVG. AGE DISTRIBUTION IN 79 - 80 :

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	1.5	0.5	1.5	0.0	2.0	2.5	0.0	0.0
ASSC PROF.	0.0	0.0	0.5	2.5	0.5	0.5	4.0	1.0	0.5	0.0	0.0
ASST PROF.	0.0	13.0	0.5	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	0.0	4.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
ALL RANKS	0.0	13.0	5.0	6.0	2.0	3.0	4.0	3.0	3.0	0.0	0.0

AVG. AGE DISTRIBUTION IN 84 - 85 :

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	0.5	2.5	1.0	1.5	0.0	2.0	0.0	0.0
ASSC PROF.	0.0	0.0	0.5	0.0	1.5	0.5	0.0	3.0	1.0	0.0	0.0
ASST PROF.	0.0	9.5	8.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	0.0	0.0	4.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0
ALL RANKS	0.0	9.5	8.5	4.5	6.0	2.5	2.0	3.0	3.0	0.0	0.0

TIME: 20.20 SECS.

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FILES: USCFIL, FACFIL

# ITERATIONS REQUESTED ?2

PLANNING HORIZON: ANY CHANGES (Y OR N) ?Y
PRESENTLY 10 YEARS FROM 75 TO 84 INCLUSIVE.
ENTER FIRST YEAR OF PLANNING PERIOD (E.G., 75) ?75
ENTER # YEARS IN PLANNING PERIOD (MAX.= 20) ?20

RETIREMENT POLICY: ANY CHANGES ?Y
RETIREMENT POSSIBLE FOR AGES 60 TO 65
     CHANGE 60 TO ?63
     CHANGE 65 TO ?68
PRESENTLY FOR AGES 63 TO 68 : 0  0  0  0  0  1
AGE 63 :  CHANGE 0      TO ?.1
AGE 64 :  CHANGE 0      TO ?.1
AGE 65 :  CHANGE 0      TO ?.1
AGE 66 :  CHANGE 0      TO ?.1
AGE 67 :  CHANGE 0      TO ?.2
AGE 68 :  PROBABILITY   =   1

INITIAL DATA PROBABILITIES: ANY CHANGES ?Y

                QUIT          TENURE
FULL PROF.      0.025          1
ASSC PROF.      0.02           1
ASST PROF.      0.105          0.25
INSTRUCTOR      0              0

ANY CHANGES (Y OR N) ?Y
1)FULL  2)ASSC  3)ASST  4)INST  5)NONE     WHAT NUMBER ?1
ENTER QUIT, TENURE: ?.025,1
1)FULL  2)ASSC  3)ASST  4)INST  5)NONE     WHAT NUMBER ?5

              PROBABILITY OF BEING REPLACED BY:
                FULL          ASSC          ASST          INST
FULL PROF.      0.25          0.15          0.6           0
ASSC PROF.      0.1           0.25          0.65          0
ASST PROF.      0.01          0.05          0.94          0
INSTRUCTOR      0             0             0             1

ANY CHANGES (Y OR N) ?Y
1)FULL  2)ASSC  3)ASST  4)INST  5)NONE     WHAT (ROW) NUMBER ?2
ENTER FULL, ASSC, ASST, INST: ?.1,.25,.65,0
1)FULL  2)ASSC  3)ASST  4)INST  5)NONE     WHAT (ROW) NUMBER ?5

              CHARACTERISTICS OF NEWLY-HIRED FACULTY:
                              SALARY        # YRS. TILL
                AGE           (1,2,3)     TENURE DECISION
FULL PROF.      45              2             4
ASSC PROF.      35              2             4
ASST PROF.      27              2             7
INSTRUCTOR      27              2             7

ANY CHANGES (Y OR N) ?Y
1)FULL  2)ASSC  3)ASST  4)INST  5)NONE     WHAT NUMBER ?3
ENTER AGE, SALARY, # YRS. TILL TENURE DECISION: ?27,2,7
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PROMOTION POLICY: ANY CHANGES ?Y
WILL NOT PROMOTE TO PROF. IF 12 YRS. PAST TENURE
     CHANGE 12 TO ?12
WILL NOT PROMOTE TO PROF. IF OVER AGE 45
     CHANGE 45 TO ?45
PROB. OF PROM. TO PROF. IN FIRST 2 YRS. AFTER TENURE IS 0.1
     CHANGE 2 TO ?2
     CHANGE 0.1 TO ?.1
PROB. OF PROM. TO PROF. AFTER 2 YRS. OF TENURE IS 0.25
     CHANGE 0.25 TO ?.25
PROB. OF PROM. TO ASSC. PROF. WITHOUT TENURE IS 0
     CHANGE 0 TO ?0
PROB. OF PROM. TO ASSC. IF TENURED THIS YEAR IS 1
     CHANGE 1 TO ?1
PROB. OF PROM. FROM INST. TO ASST. PROF. IS 0
     CHANGE 0 TO ?0

% FEMALES HIRED / % MINORITIES HIRED: ANY CHANGES ?Y
 23.1 % OF FACULTY IS FEMALE
ENTER % FEMALES TO BE HIRED (0-100): ?23
 7.7 % OF FACULTY IS MINORITY
ENTER % MINORITY TO BE HIRED (0-100): ?8

FACULTY REQUIREMENTS: ANY CHANGES ?Y
CURRENT # OF FACULTY     = 39
FULL-TIME EQUIVALENTS    = 0
TOTAL AVAILABLE FACULTY = 39
F.T.E. AS % OF TOTAL     = 0
ENTER FAC. REQUIREMENTS FOR 1ST 10 YRS. SEPARATED BY COMMAS:
 ?39,40,41,42,42,43,44,45,46,47
ENTER FAC. REQUIREMENTS FOR 2ND 10 YRS. SEPARATED BY COMMAS:
 ?48,49,50,51,52,51,50,49,48,47
ENTER DESIRED % F.T.E. (0-100): ?10
ANNUAL COST OF ONE FULL-TIME EQUIVALENT (F.T.E.) IS 6400
     CHANGE 6400 TO ?6400
HIRING PROBABILITIES FOR FACULTY ENLARGEMENT: ANY CHANGES ?Y
PRESENTLY (PROF., ASSC., ASST., INST.): 0.1  0.3  0.6  0
ENTER HIRING PROBS. FOR PROF., ASSC., ASST., INST.
SEPARATED BY COMMAS: ?.1,.3,.6,0
```

INITIAL FACULTY DATA:

CURRENT FACULTY	TOTAL	TENURED	MALE	FEMALE	MINORITY
FULL PROF.	7	6	6	1	0
ASSC PROF.	11	10	10	1	1
ASST PROF.	14	2	11	3	0
INSTRUCTOR	7	0	3	4	2
ALL RANKS	39	18	30	9	3

CURRENT FACULTY COST (1000'S) = $ 638.7
AVERAGE FACULTY AGE (YEARS) = 41.5

INITIAL AGE DISTRIBUTION:

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	0.0	1.0	0.0	2.0	3.0	1.0	0.0	0.0
ASSC PROF.	0.0	0.0	2.0	1.0	1.0	4.0	1.0	1.0	1.0	0.0	0.0
ASST PROF.	0.0	1.0	6.0	5.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	4.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ALL RANKS	0.0	5.0	10.0	7.0	4.0	4.0	3.0	4.0	2.0	0.0	0.0

RESULTS:

RETIREMENT STATISTICS:

RETIREMENT AGE:	63	64	65	66	67	68
AVG. # RETIRED:	2	0	0.5	1.5	1.5	2

FACULTY CHANGES:

	75	76	77	78	79	80	81	82	83	84
AVG. NO. OF QUITS	2.5	1.5	1.0	1.0	1.5	2.0	3.0	3.5	1.5	2.5
AVG. NO. OF DEATHS	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.5
AVG. DENIED TENURE	0.0	1.0	2.0	1.0	2.5	0.5	0.0	0.0	0.5	1.5
AVG. NO. RETIREMENTS	0.0	0.0	1.0	0.0	0.5	0.5	0.0	1.0	1.0	0.5
AVG. NO. TENURED	0.0	2.0	0.5	0.0	0.5	1.5	1.0	0.5	0.0	1.0
AVG. NO. PROMOTED	0.0	1.0	1.0	0.0	1.5	1.5	0.5	1.5	0.0	0.0
ORIG. FAC. DEPARTING	2.5	5.0	9.0	10.5	14.5	17.5	18.0	19.0	20.0	22.5
CUM. NO. HIRES	0.0	2.5	7.0	10.0	15.0	19.5	23.5	29.0	32.0	38.0

FACULTY CHANGES:

	85	86	87	88	89	90	91	92	93	94
AVG. NO. OF QUITS	0.5	1.5	2.5	2.0	1.0	1.5	3.0	1.5	2.5	2.5
AVG. NO. OF DEATHS	0.0	0.0	0.0	0.0	0.5	0.5	0.0	0.0	0.0	0.0
AVG. DENIED TENURE	0.0	1.5	1.0	1.0	3.5	1.0	1.0	0.0	2.0	1.5
AVG. NO. RETIREMENTS	0.0	0.0	0.5	0.5	0.5	0.5	0.0	0.5	0.0	0.5
AVG. NO. TENURED	1.5	2.0	1.0	2.0	0.5	0.0	2.0	0.0	0.5	1.5
AVG. NO. PROMOTED	0.5	2.0	0.5	0.5	0.5	2.0	2.0	0.0	1.0	2.5
ORIG. FAC. DEPARTING	22.5	23.0	24.5	25.5	26.0	27.5	27.5	28.0	28.0	28.5
CUM. NO. HIRES	38.5	41.5	45.5	49.0	54.5	58.0	62.0	64.0	68.5	73.0

FACULTY DATA:

	75	76	77	78	79	80	81	82	83	84
AVG. NO. PROF.	7.0	8.0	8.0	7.5	8.0	8.5	7.5	8.5	7.5	6.0
AVG. NO. ASSOC.	11.0	11.0	11.0	11.5	10.0	9.5	10.0	8.5	9.5	10.0
AVG. NO. ASST.	11.5	10.5	11.0	12.0	13.0	14.0	15.5	17.0	17.0	19.0
AVG. NO. INST.	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
AVG. NO. F.T.E.	2.5	3.5	4.0	4.0	4.0	4.0	4.0	4.0	5.0	5.0
FAC. REQ'D. (10'S)	3.9	4.0	4.1	4.2	4.2	4.3	4.4	4.5	4.6	4.7
AVG. FACULTY AGE	43.0	43.4	42.7	42.6	41.5	40.4	40.5	40.0	39.9	38.6
AVG. SALARY (1000'S)	16.9	17.1	16.7	16.5	16.3	16.0	15.9	15.7	15.5	14.7
AVG. COST (100K'S)	6.3	6.5	6.4	6.5	6.4	6.5	6.6	6.7	6.7	6.5
AVG. % FAC. TENURED*	47.9	53.4	48.6	46.1	43.4	39.7	40.0	37.8	35.4	31.0
AVG. % FEMALE	21.9	21.9	24.3	27.6	30.3	26.9	25.0	23.2	23.2	23.8
AVG. % MINORITY	8.2	8.2	9.5	9.2	9.2	10.3	11.3	11.0	13.4	14.3
AVG. % F.T.E.	6.4	8.8	9.8	9.5	9.5	9.3	9.1	8.9	10.9	10.6

FACULTY DATA:

	85	86	87	88	89	90	91	92	93	94
AVG. NO. PROF.	6.0	6.0	6.0	5.5	6.0	8.0	8.5	9.0	9.5	11.0
AVG. NO. ASSOC.	11.0	12.0	11.5	11.5	11.0	8.5	10.0	9.0	9.0	7.5
AVG. NO. ASST.	18.0	17.0	17.5	18.0	18.0	18.5	16.5	17.0	16.5	16.5
AVG. NO. INST.	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
AVG. NO. F.T.E.	6.0	7.0	6.0	9.0	10.0	9.0	8.0	7.0	6.0	5.0
FAC. REQ'D. (10'S)	4.8	4.9	5.0	5.1	5.2	5.1	5.0	4.9	4.8	4.7
AVG. FACULTY AGE	39.6	39.9	39.6	39.4	39.2	38.9	39.6	40.1	40.7	40.8
AVG. SALARY (1000'S)	15.0	15.0	14.9	14.7	14.7	14.8	15.1	15.2	15.4	15.6
AVG. COST (100K'S)	6.7	6.8	6.8	6.7	6.8	6.8	6.8	6.8	6.9	6.9
AVG. % FAC. TENURED	34.5	38.1	36.9	39.3	39.3	35.7	40.5	39.3	39.3	41.7
AVG. % FEMALE	23.8	23.8	25.0	25.0	26.2	27.4	23.8	23.8	26.2	26.2
AVG. % MINORITY	14.3	13.1	14.3	15.5	15.5	11.9	10.7	10.7	11.9	10.7
AVG. % F.T.E.	12.5	14.3	16.0	17.6	19.2	17.6	16.0	14.3	12.5	10.6

BASED ON AVERAGE OF 2 ITERATIONS

*Output of % total faculty dollars to tenured faculty may also be specified.

EXPECTED # ORIGINAL PROFS BY DEPT. REMAINING AT SCHOOL:

DEPT.	74	76	78	80	82	84	86	88	90	92	94
1	21.0	18.5	16.0	11.0	10.0	7.5	7.5	6.5	5.0	5.0	4.5
2	18.0	15.5	12.5	10.5	10.0	9.0	8.5	7.0	6.5	6.0	6.0

EXPECTED # CUM. OPENINGS BY DEPT. EACH YEAR:

DEPT.	76	78	80	82	84	86	88	90	92	94
1	2.5	5.5	11.5	17.0	21.0	23.0	26.5	31.5	34.5	40.5
2	2.5	5.5	8.0	10.0	13.5	15.0	19.0	21.5	24.5	27.0

	TOTAL FAC. HIRED OVER 20 YRS.	FAC. COST (1000'S) IN 94 - 95	AVG. FAC. AGE IN 94 - 95	% FAC. TENURED IN 94 - 95
MIN.	70.0	664.0	40.4	38.1
MEAN	73.0	686.0	40.8	41.7
MAX.	76.0	708.0	41.1	45.2

AVG. AGE DISTRIBUTION IN 79 - 80 :

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	1.0	0.0	2.5	0.0	2.0	2.5	0.0	0.0
ASSC PROF.	0.0	0.0	0.0	3.0	0.5	0.5	3.5	1.0	0.5	1.0	0.0
ASST PROF.	0.0	11.0	0.0	0.0	1.5	0.5	0.0	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	0.0	4.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0
ALL RANKS	0.0	11.0	4.0	6.0	3.0	3.5	3.5	3.0	3.0	1.0	0.0

AVG. AGE DISTRIBUTION IN 84 - 85 :

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	0.0	3.0	0.5	2.0	0.0	0.5	0.0	0.0
ASSC PROF.	0.0	0.0	1.0	3.5	0.5	0.5	0.0	3.5	1.0	0.0	0.0
ASST PROF.	0.0	13.5	5.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	0.0	0.0	4.0	2.0	1.0	0.0	0.0	0.0	0.0	0.0
ALL RANKS	0.0	13.5	6.0	7.5	5.5	2.5	2.0	3.5	1.5	0.0	0.0

AVG. AGE DISTRIBUTION IN 89 - 90 :

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	0.5	0.5	3.5	0.0	1.5	0.0	0.0	0.0
ASSC PROF.	0.0	0.0	1.0	3.5	3.0	0.0	0.5	0.0	3.0	0.0	0.0
ASST PROF.	0.0	14.5	3.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	0.0	0.0	0.0	4.0	2.0	1.0	0.0	0.0	0.0	0.0
ALL RANKS	0.0	14.5	4.5	4.0	7.5	5.5	1.5	1.5	3.0	0.0	0.0

AVG. AGE DISTRIBUTION IN 94 - 95 :

RANK	21 25	26 30	31 35	36 40	41 45	46 50	51 55	56 60	61 65	66 70	71 75
FULL PROF.	0.0	0.0	0.0	0.5	2.5	3.0	3.5	0.0	1.5	0.0	0.0
ASSC PROF.	0.0	0.0	0.5	4.0	1.0	1.0	0.0	0.5	0.0	0.5	0.0
ASST PROF.	0.0	10.5	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
INSTRUCTOR	0.0	0.0	0.0	0.0	0.0	4.0	2.0	1.0	0.0	0.0	0.0
ALL RANKS	0.0	10.5	6.5	4.5	3.5	8.0	5.5	1.5	1.5	0.5	0.0

TIME: 37.25 SECS.